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Introduction

The inaugural International Semantic Web Doctoral Symposium (ISW DS) is a forum for an invited group of doctoral students to present their work and obtain guidance from mentors as well as to provide contact with other students at a similar stage in their careers. Mentors at the symposium are senior university or industry researchers, e.g., current or former members of the International Semantic Web Conference (ISWC) program committee. The goal of the symposium is to expose students to helpful criticism before their thesis defence, and to foster discussions related to future career perspectives. Mentors provide constructive criticism on the current work, and give advice for possible future direction and focus. A similar series of doctoral symposia is held in connection with the OOPSLA, ECOOP and Middleware conferences.

The symposium consists of a full-day workshop followed by an informal dinner. Participants will also present a poster at the conference poster session, providing further opportunity for additional feedback and experience in communicating with other researchers. Students at the beginning of their research, who are interested in learning about structuring research and obtaining research direction, are welcome to attend the symposium as observers.

We would like to give a special thanks to all the mentors for their time and effort attending the symposium and providing constructive reviews.

November 2005

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Knowledge Modeling for Integrating Semantic Web Services in E-Government Applications

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1 Research Description

The importance of Knowledge Management (KM) is being increasingly recognized in the public sector, in relation to e-Government realizations. Every Public Administration (PA) makes use of knowledge to increase the productivity of its activities [1]. Therefore efficient, scalable and flexible KM Systems (KMS) and coherent strategies are needed to support the PA's. Nonetheless, due to a debatable success of current KM implementations, it is still unclear how such topics should be addressed in highly distributed and heterogeneous environments [2].

The current trends in e-Government applications call for joined-up services that are simple to use, shaped around and responding to the needs of the citizen, and not merely arranged for the provider's convenience. In this way, the users need have no knowledge of – nor direct interaction with – the government entities involved. Thus, services need to be interoperable in order to allow for data and information to be exchanged and processed seamlessly across government.

The Semantic Web [3] aims to alleviate these problems. By allowing software agents to communicate and understand the information published, the Semantic Web enables new ways of consuming services. In particular, the Semantic Web Services (SWS) technology provides an environment in which new services can be added, discovered and composed continually, and the PA processes automatically updated to reflect new forms of cooperation [4]. The SWS provide an infrastructure for agent-to-agent communication.

However, (i) the PA does not necessarily use this infrastructure to represent knowledge internally. Organizations can adopt the workflow paradigm to describe their processes [5]. (ii) The PA work routines involve interactions with non-software agents, such as citizens, employees, managers and politicians. Multiple viewpoints should be considered. (iii) In real cases, component services are not atomic, and cannot in general be executed in a single-response step; they require to follow an interaction protocol that may involve multiple sequential, conditional and iterative steps. For instance, a service may require a negotiation between the user and the provider. Thus, the PA's do not necessarily "talk" in terms of Semantic Web Services.

In my PhD thesis I argue that a more complex semantic layer is to be modelled – and a middleware system designed on such a model – in order to meet the requirements of real-life applications. As a result, the integration of the SWS requires the definition of a model of interaction between the domains of e-Government (and their actors: citizens, employees, managers, politicians, programmers) and the Semantic Web. The goal of my thesis is to provide an approach and define such a model.

The main issues are: (i) *Conceptual modeling*. Ontologies are used to define the models describing the semantic structure of knowledge. (ii) *Infrastructure for semantic interoperability*. Software modules are used to implement the functionalities of the middleware system: mediating between e-Government systems and the Semantic Web; enabling the automated interpretation and paving a common ground for services.

My present work concerns the former issue, on which I shall focus in the sequel. The main result is the creation of the following three ontologies (Figure 1).

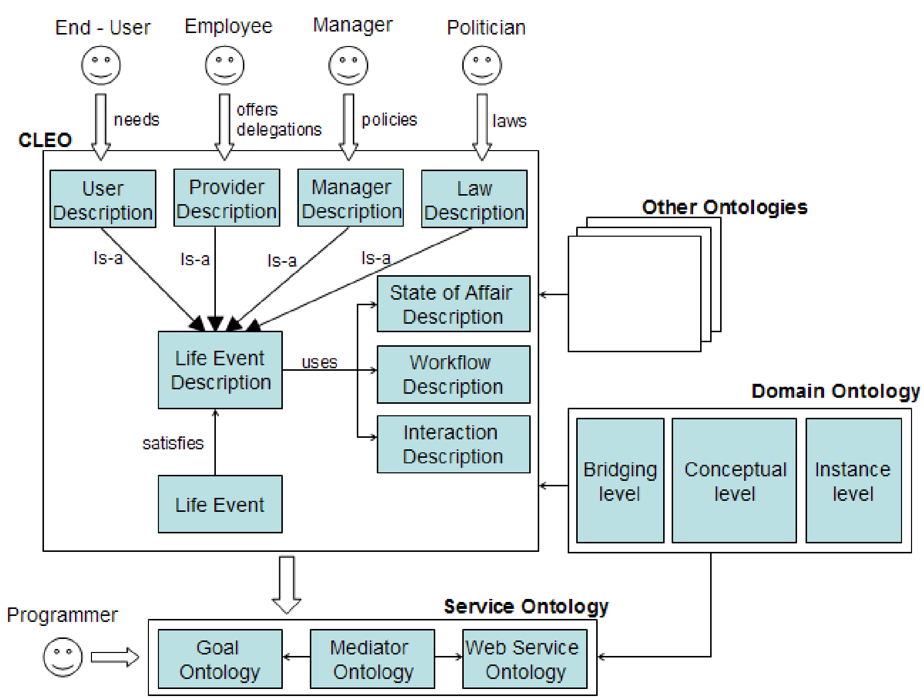

Fig. 1. Architecture of the conceptual model.

Domain Ontology [6]. It encodes concepts of the PA domain. The aim is defining an abstract reference model enabling the definition of distinct domain ontologies and addressing the mismatch problem. Every PA should keep its autonomy in describing its own domain. Actually, distinct PA's could use or describe the same concepts differently. I defined a meta-ontology that resides on three levels of abstraction: instance, conceptual and bridging level. The first one contains all instances of the conceptual level within the specific PA domain. The second describes commonly accepted and standardized concepts and properties that can be ended and adapted within the extensions of the PA domain. The bridging level has been introduced to solve mismatch problems between similar concepts defined within different PA domains.

Service Ontology[6]. It contains the SWS definitions. We considered both the main existing approaches: OWL-S [7] and WSMO [8]. Because of its mediation-oriented and decoupled architecture, we have chosen WSMO as the reference model to represent the SWS's. The Service Ontology is composed of three ontologies: Web Service, Goal and Mediator. Following the WSMO definitions, the *Web Service Ontology* contains the descriptions of all the services supplied; the *Goal Ontology* represents the goals users would like to achieve; the *Mediator Ontology* represents all the WG- and OO-mediators addressing the interoperability issues at protocol, process and data level.

Core Life Event Ontology (CLEO). Describes the e-Government service-supply structure and maps it onto the SWS definitions. CLEO is a *core ontology* derived from DOLCE [9], which allows to contextualize[1] an e-government scenario in terms of state of affairs – actors, resources, attributes and parameters –, workflow and interaction descriptions. The central concept of CLEO is the *life event,* which originates the supply of services by the PA's. Actually, the life event is the point of contact among the actor viewpoints. The various views naturally focus on different aspects of a life event: the user's one includes the description of his/her needs; the employee's one, the description of offers and delegated tasks; the manager's one the policies influencing the service implementations; the politician's one, the description of laws ruling the scenario.

The user and provider viewpoints include a functional and non-functional description to express their needs and offers; they also refer to the interaction model to define the kind of accomplishment (e.g., communication, inquiry, notification, transaction, ...), and the set of transition events composing the interaction protocol. At the moment, these representations are mapped onto the WSMO concepts, but other approaches such as OWL-S can be integrated.

The manager and politician viewpoints manage the evolution of knowledge; as a matter of fact, a change in a law or a policy can have repercussions onto the service supply.

It is important to notice that the concepts used for the actor's view are linked to the objects of the domain ontology they act upon. Moreover, each view refers to the specific domain ontology defining the actor's language.

Furthermore, CLEO has been designed to be general and modular: it can be readily extended and connected to other more specific ontologies. For instance, the law description can be associated with concepts of an existing legal ontology.

[1] Describing various notions of context, non physical situations, topics, plans, beliefs, etc. as entities [9]

These properties enable CLEO to be used in different contexts and projects within the e-government scenario.
Finally, CLEO introduces a methodology that first helps domain experts to create a full description of a specific e-government context, and then drives the programmers to implement SWS descriptions.

Designed on a preliminary version of the conceptual model, an architecture of a One-Stop Government Portal [1] has been proposed in [4], extended with a semantically-enhanced middleware. In particular, a case study for the *change of circumstance scenario* – within the DIP project [10] – has been developed to explore the usability of the ontology models. A new architecture will be proposed, based on the current conceptual model, in which the Portal plays the role of a unique access to a multi-agent service-supply environment.

At the moment I'm working on the distribution problem. Each ontology is already an example of distributed and flexible approach. Starting from the models, the aim is to design a general framework for the whole scenario. Each PA is an independent node describing its own knowledge, as well as mechanisms of sharing information and mismatch resolution.

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Re-use and alignment of ontologies: the art-E-fact ontology as an extension of the CIDOC Conceptual Reference Model (CRM)

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Abstract. With the growing use of ontologies in various domains of interest, the problem of overlapping knowledge in a common domain becomes critical. In this context, much work has already been done developing semi-automated applications that enable the merging, mapping or alignment of ontologies. On the other hand, a big effort is being currently developed by many communities (e.g. eLearning, telemedicine, cultural heritage) in order to standardize their contents and data models facilitating the integration and exchange of content coming from heterogeneous data sources

1 Introduction

Ontologies have been established as effective and efficient means of knowledge sharing. A unified representation for Web data and resources is needed in today's large scale Internet data management systems. This unification through standards will allow machines to meaningfully process the available information and to exchange and integrate data coming from distributed databases and information management systems.

For the semantic technologies to succeed in the field of information exchange and interoperability between cultural institutions there is a great need to gain interoperability using standard ontologies. Semantic Web technologies can enable the heritage sector to make its information available in meaningful ways to researchers, its own curators, the didactic departments and even the general public. Delivering these technologies to the heritage sector depends on the syntactical and semantic mark-up of content, the development of better knowledge analysis and modelling tools, widespread adoption of interoperable knowledge representation languages and the implementation of suitable ontologies.

This paper is organized as follows. Section 2 presents previous work upon which this article is based. Section 3 describes the methodology and Section 4 has some conclusions.

2 Previous work

2.1 The CIDOC Conceptual Reference Model (CRM)

The CIDOC CRM is the outcome of a long-term multidisciplinary knowledge engineering activity. The primary role of the CRM is to enable information exchange and integration between heterogeneous sources of Cultural Heritage information [2]. It aims at providing the semantic definitions and clarifications needed to transform localized information sources into a coherent global resource.

More specifically, it defines and is restricted to the underlying semantics of database schemata and document structures used in cultural heritage and museum documentation in terms of a formal ontology. It explains the logic of what they actually currently document and thereby, enables semantic interoperability.

The CRM is a domain ontology in the sense used in computer science. It has been expressed as an object-oriented semantic model being readily converted to machine-readable formats such as RDF Schema, KIF, DAML, or OWL. Currently (i.e. version 4.0), it contains 81 classes and 132 unique properties. It should be mentioned that it does not attempt to articulate the inheritance of properties by subclasses throughout the class hierarchy.

2.2 The art-E-fact ontology

The art-E-fact ontology has been developed within the art-E-fact (IST-2001-37924) IST Project. The main objective of the art-E-fact ontology is to provide artists with knowledge about the content available in the database to build a story. The art-E-fact model, driven by artists and content generators requirements, is motivated by the need to describe added-value content for the creation of stories.

The art-E-fact domain ontology is composed of 84 classes and 173 properties and has been implemented in RDF Schema. It represents the artworks and its relational data stored in the AWDB and it is referred to five levels of knowledge, enriched with a set of metadata or descriptors of the data of the diagnosis. All these levels of knowledge or "thematic entities" in the ontology conception are supported by the scientific diagnosis results and the related documentation: work identification; description; aesthetic appearance; technical; and interpretation.

3 Methodology

The CIDOC CRM and the art-E-fact ontology reflect a serious commitment to the expression of common concepts underlying the data structures used by their domain users. However, there are quite a lot of differences among both knowledge models.

Scope. The intended scope of the CIDOC CRM includes all the information required for the scientific documentation of Cultural Heritage collections, enabling wide area information exchange and integration of heterogeneous sources. The main objective of the art-E-fact ontology is to content description and comprehension.

Cultural artworks. In the context of the CRM, the term 'Cultural Heritage collections' is intended to cover all types of material collected and displayed by museums and related institutions, as defined by ICOM. The art-E-fact ontology is also valid for interpretation centres and humanistic research institutions, which may have access to data and are not included among the ICOM concept.

Target user. The intended user of the CIDOC CRM is the curator or historian, while content generators and artists are target by the art-E-fact ontology.

Type of information. The CIDOC CRM is specifically intended to cover contextual information. On the other hand, the art-E-fact ontology takes into account different levels of knowledge in order to provide rich content to build interactive amazing stories.

Thus, there is no incompatibility between both models. The art-E-fact domain ontology covers five levels of knowledge or thematic entities (Identification, Description, Aesthetic, Technical and Interpretation) concerning artworks. On the other hand, the CIDOC CRM ontology focuses on documentation processes (the equivalent to the Identification level of knowledge) among cultural institutions.

As the art-E-fact domain ontology can be to the CRM, the current PhD thesis is proposing to incorporate the art-E-fact domain ontology into the CRM as part of the standard. In order to achieve this goal, the following methodology has been defined:

Similar languages. A new version of the art-E-fact ontology using Description Logic based Ontology Language (OWL DL) is required. The art-E-fact ontology was built using the Resource Description Framework (RDF), meanwhile the CIDOC CRM is accessible in OWL DL.

Identification of common concepts and standardization. For the alignment of both ontologies we are going to use a rule-based methodology by the means of the emerging Semantic Web rule languages. Reasoning languages for the Web are an emerging technology that does not exist today. This technology will soon represent an essential breakthrough for Web systems and applications. One possible rule-based ontology language that we can use in this process is the Web Rule Language (WRL) for the Semantic Web. This language is located in the Semantic Web stack next to the Description Logic based Ontology Language (OWL). The ontology vocabulary can be specified using WRL or OWL, or using their common semantic subset, denoted by the WRL-Core subset of WRL and the OWL-DP subset of OWL [Grosof et al., 2003]. With common semantic subset we mean in this context that every WRL-Core has a corresponding OWL-DP ontology and vice versa, where both ontologies entail exactly the same set of ground facts.

4 Conclusions

This paper presents the work that is being carried out in this Ph.D. Thesis. Technology, in the wider sense of its meaning, is tending to standards in order to enable and ease information exchange across different and usually distributed information management systems, should they be mobile devices or desktop computers. Thus, standards are not just a need but a must. Also, re-using existing material (for example, to extend existing standards) is something we should tend to do and it is one of the objectives pursued in this paper.

In this paper we have presented the CIDOC CRM and the art-E-fact ontologies as previous work upon which this Ph.D. is based. We have compared them and (conceptually) explained how we will incorporate the art-E-fact ontology onto the CRM in our commitment with standards and the re-use of previously developed work. In order to achieve this goal, we will study different methodologies, tools and ways of doing it and we will apply the most suitable one.

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Applying Belief Change to Ontology Evolution

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Abstract. Some of the key problems to resolve towards the realization of the vision of the Semantic Web include the creation, management and evolution of ontologies. This thesis focuses on the problem of ontology evolution. We believe that the ontology evolution community will benefit from the application of belief change techniques to ontologies and provide arguments in favor of this option. As an application of this viewpoint, we evaluate the feasibility of applying the AGM theory of contraction to the problem of ontology evolution, for ontologies represented using Description Logics (DLs) and OWL. Our approach raises interesting theoretical challenges and has an important practical impact too, given the central role that DLs and OWL play in the Semantic Web.

1 Introduction

One of the crucial tasks towards the realization of the vision of the Semantic Web is the efficient encoding of human knowledge in ontologies. The proper maintenance of these, usually large and complex, structures and, in particular, their adaptation to new knowledge (*ontology evolution*) is one of the most challenging problems in the current Semantic Web research.

There are several reasons that may force us to change an ontology. These include, but are not limited to, the need to improve the conceptualization of the domain, a shift in the users' needs or viewpoint, a dynamic change in the modeled domain, access to information previously unknown, classified or otherwise unavailable and so on.

2 Motivation

Current ontology evolution methods are based on varying levels of human intervention in order to perform properly. In particular, human participation is required in phases 2 and 3 of the ontology evolution process [8], namely the *Change Representation* and the *Semantics of Change* phase, during which the change(s) is (are) properly represented and the exact modifications required in the ontology in order to realize this (these) change(s) are determined.

We find the need for human intervention overly restrictive for real-world applications. The human user that intervenes in the process should be an ontology engineer and have certain knowledge on the domain. Very few people can be both domain and ontology experts. But even for these specialized experts, it is very hard to perform ontology evolution manually [8], because ontologies are large, complex structures with several and often unexpected interdependencies between their elements. Complex ontologies are developed by several ontology engineers; persons performing changes may be unaware of the full extent of their changes' effects, as they may not know all the parts of the ontology. In fact, no single ontology engineer may be in position to determine the full effects of a change. Finally, it is unrealistic to assume that an ontology engineer will always be nearby whenever an ontology needs to evolve; such an assumption overrules the use of ontologies in robots, agents and other automated systems. For all the above reasons, we think it is simply not practical to rely on humans for ontology evolution.

To develop fully automatic ontology evolution algorithms, several issues need to be addressed in a formal manner. For example, how can one track down all the alternative ways to address a given change, using a formal and exhaustive process? How can a computer system decide automatically on the "best" of the different alternatives? Most importantly, what is the definition of "best" in this context? Are there any properties that should be satisfied by a "good" ontology evolution algorithm? Unfortunately, resolving these issues in a general manner is not easy using the current research direction. Unless a more formal path is taken, ontology evolution research is doomed to never find answers to such questions.

2 Our General Proposal

In this thesis, we propose the use of *belief change* [7] techniques to address these issues. The problem of belief change is a very interesting and extensively studied problem which deals with the issue of deciding the changes to be performed upon a Knowledge Base (KB) in the face of new, possibly contradictory, information. We can view the problem of ontology evolution as a special case of the more general problem of belief change; this makes the problem of ontology evolution very similar, in several aspects, to belief change. Thus, building upon results from the rich belief change literature may help ontology evolution researchers to develop proper, automatic, rational and efficient evolution methods for ontologies.

This proposal can be viewed as a supplementary research direction, focusing on phases 2 and 3 of ontology evolution. It will allow the automatic determination of the proper modifications to be performed upon the ontology in response to a certain need for change, eliminating the need for human participation in these phases. Following this determination, the result could be fed to one of the current ontology evolution algorithms for final implementation. More details regarding this proposition, as well as a thorough discussion on the connections between belief change and ontology evolution can be found in [5].

3 A More Specific Proposal – Related Results

For the purposes of this thesis, this ambitious and abstract objective has been significantly reduced; more specifically, we studied the problem of determining the feasibility of applying the *AGM theory of contraction* [1] (the most influential theory of belief change) to ontologies based on DLs [2] and OWL [3], two families of languages which are expected to play a key role in the development of the Semantic Web.

The AGM theory set the foundations for future research in the field of belief change by introducing three different belief change operations, namely *expansion*, *revision* and *contraction*, as well as certain conditions, the so-called *AGM postulates*, which should be satisfied by any rational revision and contraction operator. The intuitions behind the development of the AGM postulates are independent of the actual language used to represent the knowledge. This supports our belief that several concepts used in belief change (in this case the concept of a "rational" operator) are transferable to the ontology evolution context. On the other hand, the exact formulation of the AGM postulates themselves uses certain assumptions made by AGM, which overrule several knowledge representation languages, including DLs and OWL.

This problem is typical of the problems encountered during the migration of belief change techniques to the ontology evolution context: the differences on the underlying intuitions are minimal, but the representation languages and formalisms used are quite different. In such cases, it makes sense to recast the theory under question (in this case the AGM theory) in a setting general enough to contain ontology representation languages (like DLs and OWL). For the purposes of this work, the operation of contraction was chosen because, according to AGM, it is the most fundamental among the three belief change operators [1] (even though revision is more often used in practice). Our research on revision is currently at a preliminary stage [6].

Our approach dropped most AGM assumptions and extended the definition of the contraction (and revision) operator; these generalizations were necessary to allow DLs and OWL (as well as several more representation languages) to be engulfed in our framework. Having set this general framework, the next step was to reformulate the AGM postulates of contraction in such a way as to be applicable to all logics in our more general framework, while preserving the original intuitions that led to each postulate's definition. The resulting postulates can be found in [4] and coincide with the original ones in the presence of the AGM assumptions.

Unfortunately, a major problem appeared soon after this reformulation: not all logics in our framework can admit a contraction operator that satisfies the (generalized) AGM postulates. Following this observation, our focus shifted on defining the conditions under which a logic admits a contraction operator satisfying all postulates; such logics were called *AGM-compliant logics*. Three different necessary and sufficient conditions for a logic to be AGM-compliant were formulated, based on the notions of *decomposability*, *cuts* and *max-cuts* (see [4] for details). As a side-effect, our work uncovered interesting connections of the AGM theory with lattice theory and provided a definite answer on the issue of the relation of the AGM theory with belief base algorithms and the foundational viewpoint [4].

Given the theoretical foundations set by this work, we were able to determine the applicability of the AGM theory to DLs and OWL. It was shown that if a DL allows a certain transformation to be defined, then it is AGM-compliant. This transformation is definable under very generic conditions and its existence depends on the operators, connectives and axioms allowed by the DL. Negative results were also presented, showing that certain DLs commonly used in ontologies, as well as OWL DL and OWL Lite, are not AGM-compliant. Finally, certain rules of thumb allowing one to determine the AGM-compliance of DLs not covered by this work, as well as some preliminary results related to revision were formulated. For more details, refer to [6].

4 Conclusion and Future Work

We believe that the study of belief change techniques under the prism of ontology evolution will lead to important breakthroughs in the field of ontology evolution. The significant work that has been performed during the last 20 years in the field of belief change will allow ontology evolution researchers to avoid re-inventing the wheel for problems whose counterparts have already been studied in the belief change literature.

The work performed in this thesis shows that this approach is generally feasible and may produce interesting results. However, our work was only restricted to one possible alternative of this more general research proposal, namely the connection of the AGM theory with ontology evolution. Therefore, this thesis has only scratched the surface of the problem, leaving several other alternatives unexplored.

Future work, in the context of this thesis, consists in developing an extension of this work to the operation of revision. We also plan to work on the issue of developing an AGM-compliant ontology evolution algorithm that could be used for integration in tools used for ontology evolution (existing or currently under development).

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Semantic Web as a Platform for Distributing Cognition

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Abstract. This paper presents an outline of the doctoral thesis work concerning the distribution of cognition in the Semantic Web. The Semantic Web is considered as a platform having a potential to expand the sphere of distributing cognition significantly. First, as an extension of the current Web it will contain vast amount of information waiting to be used, if appropriately filtered. Secondly, since the material in the Semantic Web has machine-accessible meaning, it will provide a basis for software agents in addition to human beings to distribute cognition. The thesis work will investigate the characteristics of distributing cognition for both humans and software agents, and in both single agent and multiagent scenarios.

1 Description of Purpose and Goal Statement

Being an extension of the current Web with information in a machine-accessible form, the *Semantic Web* is an environment for both human and software agents to create and consume content [1, 4]. Creating and consuming content can be seen through the theory of *distributed cognition*, which emphasises the participation of external elements in agents' thinking processes. The work reported in this paper aims at combining these two research areas on both explanatory and design levels. Figure 1 gives an abstract depiction of this approach. Human agents (HA) can distribute their cognition to calculators, notebooks, other humans, and so on [5], but software agents (SA) only to media accessible from the virtual space they reside in. *Semantic Notes* are defined as media for distributing cognition in the Semantic Web. In principle also software agents could use physical structures for distributing cognition, for example by printing on paper, as depicted by the narrow arrow in Figure 1, but that is less relevant.

Semantic Notes can include information about anything. Therefore the notion of Semantic Note is not characterized contentually but instead functionally. A distinctive feature of Semantic Notes is their purpose; a Semantic Note is consumed and often also created in a situation calling for detailed information to assist in completing some specific task. A Semantic Note can therefore be conceived as a *tool* for thinking. More specifically, due to the domain-specificity, Semantic Notes can be considered as tools for some particular task, meaning that they do not have a purpose as such, but only in relation to the task they are used for [2]. Like all material in the Semantic Web, the Semantic Notes and the statements included in them are addressable using namespace definitions and URIs.

It is envisaged that humans and software agents will have different roles in the Semantic Web. When it comes down to it, software agents "work for" humans and that

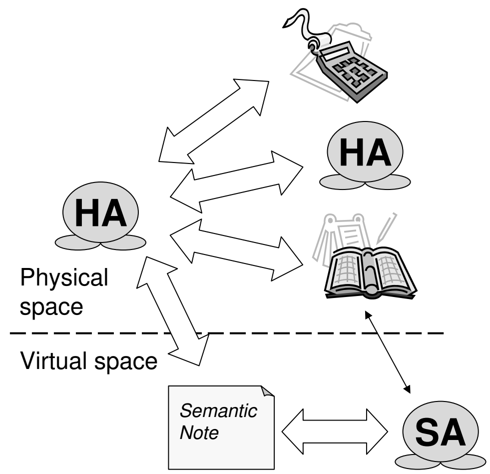

Fig. 1. Means of distributing cognition

is the reason for giving machine-accessible descriptions in the first place. Recognizing this, the ultimate goal of the research is to help people in coping with the information overload [9] they confront when facing the huge amount of material in the Web. Enabling people to retrieve relevant information with regard to their current tasks and contexts is the general abstract-level purpose of the work. That said, the work also aims at facilitating adaptable software agents. The minimum requirement for a software agent to utilize a Semantic Note is that it has access to the ontology to which the Semantic Note in question conforms, as Figure 2 depicts. Subsequently it can for example act as a dynamic information filter on behalf of the human.

2 Methodology and Evaluation

Distribution of cognition is realized via the processes of *externalization* (also called objectification [3]) and *internalization* [11, 6]. The theoretical part of this work has so far mainly focused on internalization. More specifically, a formal model for determining information usefulness in the Semantic Web is under development [10]. Such model determines whether the content in a Semantic Note is understandable and contextually relevant to the agent trying to internalize and utilize it. Typically the need for information usefulness determination arises in scenarios where the information is created and consumed by different agents, and in scenarios where the information relevance is dependent on the user contexts which vary significantly.

In order to create a complete model for distributing cognition in the Semantic Web, also externalization has to be considered. This means specifying and discussing the situations where externalizing cognition with the help of the Semantic Web is necessary, useful, likely, and so on. Distribution of cognition happens all the time with the physical space objects of Figure 1, so it should be investigated how the Semantic Notes can

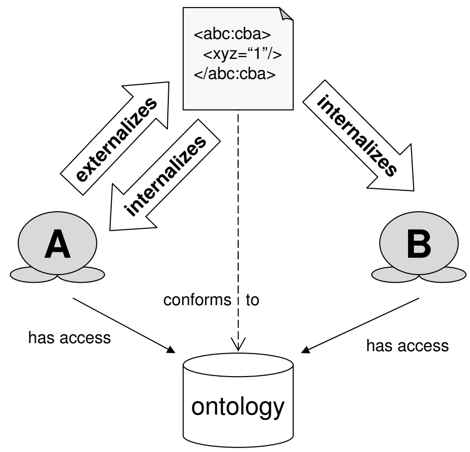

Fig. 2. Externalizing a Semantic Note to conform to an ontology

compete with those. Based on that, a set of design principles can be outlined. It is envisioned that various user interface issues such as notification means are especially important to solve, since the Semantic Notes are competing with the physical space objects for the same cognitive resources of humans.

Most of the work reported in this paper is carried out in terms of the DYNAMOS[1] research project, which investigates mobile users and how their changing contexts have effects on the information they wish to receive and utilize. Typically the most important reason for externalizing cognition is to release cognitive resources. Examples are writing down an ATM card pin code or a note about a sale in an electronics store instead of memorizing them.

The surrounding context, for example the number of parallel tasks, has impact on the cognitive load of the user [12]. This is especially evident with mobile users, for example if comparing quiet indoor environments with busy streets [7]. When at home, for example, the user can practice "planful opportunism" [8] by creating a Semantic Note about the electronics sale and setting a notification to inform about it later on when on a busy street. Without such notification, the user knows that due to the cognitively loading environment the information content carried by the Semantic Note would probably remain unnoticed, and therefore the electronics sale would be missed.

In addition to the "traditional" reason for externalization, i.e., the release of personal cognitive capabilities, information sharing is envisioned as another motivation for doing it. The written down information about the electronics sale can be shared with friends. This builds a bridge between externalization and internalization: If an agent externalizing a Semantic Note wishes to share it with other agents, it should do it in a manner that allows internalization by other agents [10]. This presupposes that the Semantic Note in question conforms to an ontology accessible to the agents, as Figure 2 depicts.

[1] Dynamic Composition and Sharing of Context-aware Mobile Services, funded by Tekes, TeliaSonera, Suunto, ICT Turku, and VTT. URL: http://www.vtt.fi/tte/proj/dynamos/

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Reducing the Complexity of Semantic Data Translation

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Abstract. In order to address the restrictions of existing program translation techniques an alternative method is proposed. The technique is demonstrated in a software tool which is used to translate between simple graphics languages. The tool uses the output errors from a schema validator to iteratively evolve from a source to a target program.

Keywords: XML, schema validator, language translation, semantic equivalence.

1 Introduction

There is a wide variety of semantically marked up languages. Translating between any two of these languages is a laborious task which requires syntactic and semantic mappings to be created. Given a system with n languages, building a direct translator between every pair of languages would require n(n-1) translators, a large amount of work. Also, adding a new language to the system will require 2(n-1) additional translators to be built.

2 Related Work

Much work on translation between computer languages was done in the 1960s. Andreyev[1] classified two approaches to language mapping, "binary translation" and "translation via an intermediate language". Binary translation is the most accurate form, but has the complexity overheads described above. Intermediate translation has a reduced complexity (2n translators), but is susceptible to the constraints of the intermediate language.

3 Method

We have investigated a technique which enables the complexity of this process to be reduced. For each language in the system there is an associated syntactic descriptor. To translate between any two languages, a generic translator is used to mould a source program into the target program using the target's syntactic

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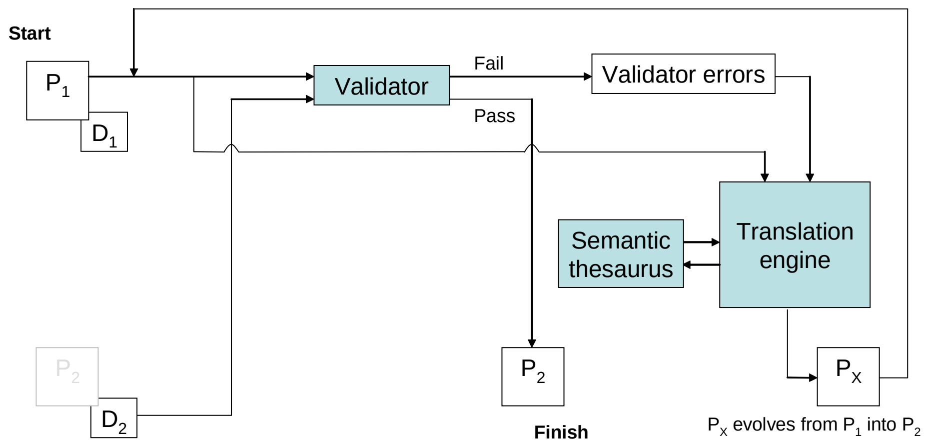
descriptor to guide this process. In this way, the complexity of the system is reduced to n descriptors and a single general purpose translator. Adding a new language to the system will only require one additional descriptor to be built.

4 Technique



The system converts a source program, P_1 into the target program P_2. Both P_1 and P_2 have associated syntactic descriptors known as D_1 and D_2. The Validator takes P_1 and validates it against D_2 to produce a set of validator errors. The Transalation Engine uses these errors to produce a new version of P_1 (known as P_X) where the errors have been resolved. The Semantic Thesaurus provides synonyms for language elements found within the program being translated.

The validator is based on the conformant schema-aware processor, XSV(XML Schema Validator)[2]. This validator takes an XML document together with an XML Schema (XSD file). If the document fails validation, the validator produces a set of errors. These errors are used in the translation engine to produce a new version of the source program where these errors are fixed. The new updated version of the program (P_X) is then returned to the validator.

The translation engine attempts to resolve the validator errors by referring to a semantic thesaurus which consists of a large collection of synonyms for language elements. The thesaurus may be specific to the domain of languages being translated (e.g. graphics languages), or could be general purpose.

When a version of P_X correctly validates against D_2, this version of P_X is deemed to be a successful translation to P_2 and the process is complete.

5 Software Proof of Concept

A software tool has been developed to demonstrate the technique. The translation domain has been limited to simple graphical scene description languages for which the tool successfully demonstrated the feasibility of this technique.

6 Future Work

We have demonstrated the concept of the technique. However, in order to make the technique more applicable to real-life languages and applications further work is needed.

XML is capable of expressing rich constructs as defined by Clover[3]. It is intended to extend the tool to handle these fully.

As the complexity of languages in the system increases, situations will arise where multiple paths of translation will be required. It is proposed to investigate resolution of multiple paths both programmatically and by the user.

The output from XSV is a human-readable error message rather than marked-up XML. A more elegant solution for interfacing XSV with the translator will be investigated.

There are additional ways of determining semantic equivalence which we would like to investigate. Equivalence is currently derived from a list of synonyms. An ontological representation of the knowledge would allow a greater level of refinement. Also we believe that comparing the similarity of construct features may prove a better metric of equivalence.

7 Conclusions

1. Existing methods of language translation lead to purpose-built translators and a potentially huge number of translators.
2. We have described an alternative technique for language translation.
3. The technique has been demonstrated in a software tool for translating between a simple subset of graphics languages.
4. The software tool relies on a feedback loop from the output of a schema validator to a translation engine which continues until the validator reports no errors.
5. We have proposed work which could be carried out to investigate the validity of this technique in real-life scenarios.

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Semantically Enriching Access Control Rules for Web Services

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Abstract. Semantic Web technologies are bring increasingly employed to solve knowledge management issues in the traditional Web technologies. This paper follows that trend and proposes using Semantic languages to construct a rule language for defining access control rules for Web Services. Using these rules, a system will be able to manage access to Web Services and also the information accessed via these services.

1 Introduction

The World Wide Web is growing at a exponential rate. There are more and more technologies being developed to provide different ways of accessing this huge information resource, as well as representing the information stored. Because of the increase in information available and people or agents accessing it, the issue of securing this information has become paramount.

Since their conception in the late 1990's Web Services have increased in popularity as a method for enabling distributing computing, both by means of Remote Proceedure Calls (RPC) and Message Oriented Middleware (MOM). The principal reason for the support of this relatively untested, insecure technology was the ease at which communication could take place through an organisations firewall. Once it became obvious that this technology was being adopted, value added services began to be developed. These included novel ways to describe, secure, coordinate and ensure reliability. My PhD will focus on securing Web Service messages.

2 Underpinning Technologies

The Semantic Web is a family of specifications and proposed technologies that were maturing in parallel to Web Services. First coined by Tim Berners-Lee at the XML 2000 conference [1], the Semantic Web, as with Web Services, has consistently increased in popularity. Interest and research in the Semantic Web however remains primarily driven by the academic community.

From the suite of standards available to Web Service developers, the eXtensible Access Control Markup Language (XACML) [2] from OASIS has the most momentum in the Web Services security arena for defining and enforcing access control rules. The Web Ontology Language (OWL) [3] is a World Wide Web Consortium (W3C) standard for defining semantically rich languages. OWL Description Logic (OWL-DL) is a subset of OWL which guarantees completeness and decidability.

3 Hypothesis

My proposed research contribution or hypothesis is to develop a semantically aware access control language for Web Services. To evaluate this hypothesis I will use the developed language to provide access control for a case study within the health sector.

4 Research Approach

It is necessary, for completion and testing of the above mentioned hypothesis, to develop a full security architecture. From research conducted into Web Service security frameworks [4] [5] [6] the principal components of a Web Service security architecture have been identified as encryption and decryption, signing and signature verification, key management and access control.

The security framework designed and implemented as part of this research is built in Java using Apache Axis as the SOAP implementation. The core encryption and decryption engine is developed using Apache's Web Service Security for Java (WSS4J) implementation of the WS-Security specification from OASIS and adheres to the W3C specification for XML-Encryption. The signing and signature verification engine is also developed using WSS4J and adheres to the W3C specification for XML-Signature. The key management is built according to the XML Key Management Specification (XKMS) by OASIS It is its own certification authority as well as managing the local key store.

The novel access control model associated with this security framework has its foundations in semantic reasoning. The access control engine will return one of three results to a request for authorisation, full access, limited access or no access. In the case of a request of authorisation for the invoking of a Web Service, only full access or no access apply, where that service returns an information set, the requester must also gain access to the information in question. This information may be pruned according to the "limited access" rules returned from the access control engine. Instead of the requester being refused the document they may be returned a subset of it.

The rule language in which the access control rules will be written will be a semantically rich language. It will be designed specifically for Web Service access control and follows the structure of XACML closely. It has not been decided at the time of submission whether the language will be developed from new or will be a subset or mutation of an existing rule language such as RuleML [7] or the Semantic Web Rule Language (SWRL) [8].

It was mentioned earlier that a case study will be undertaken in the health sector. The health sector contains huge volumes of sensitive information which is accessed by different people with different levels of authorisation. It is proposed that, in undertaking this case study, an OWL-DL form of Health Level 7 (HL7) [9] will be created. This will be populated with some sample data. This will now contain the data, semantically described, with which to evaluate our semantic rules.

5 Related Research

KAoS [10] uses OWL for reasoning about policies. KAoS was initially designed as a policy language for complex software agents, but it is now being adapted to grid computing and Web Service environments.

Rei is a distributed policy language that enables every Web entity to specify policies for its access, for privacy, for entities it wants to communicate with, etc [11]. Rei v2 is written using OWL-Lite. Rei however extends OWL-Lite to include logic-like variables.

Parsia et al, in [12], propose a semantically-aware policy language by translating WS-Policy [13] into OWL-DL.

Qin et al propose "an access control model for the Semantic Web that is capable of specifying authorisations over concepts defined in ontologies and enforcing them upon data instances annotated by the concepts" [14]. They present an OWL-based access control language SACL (Semantic Access Control Language) as the language used to create authorisation policies in their proposed model. SACL is an extension of OWL.

Damiani et al [15] outline how "current standard policy languages such as XACML can be extended" to be able to semantically define access control policies for the Semantic Web. They propose the use of RDF to make the XACML policies more semantically aware.

The model proposed in this paper differs from each of these offerings. The first three items deal with policies for Web Services, often confused with authorisation rules. A policy is the information which the owner of the service wishes to share with potential business partners. This paper describes a solution for the internal evaluation of authorisation rules. The final two areas of research are more similar to this paper, although Qin et als work does not lend itself specifically to access control for Web Services and the work of Damiani et al enriches XACML with RDF. RDF will not provide the same semantic richness as OWL.

6 Conclusion

From this research I hope to achieve a number of goals:

- An access control language of proven quality and worth.

– A complete framework for securing Web Services [16].
– A novel approach to document filtering.
– It will be possible for a user of limited technical ability to write access control rules. This can be achieved as a direct consequence of semantic descriptions of users and information sets.

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Representing Discrete-Event Simulation Models with the Web Ontology Language - OWL

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Discrete event simulation development requires significant investments in time and resources. Descriptions of discrete event simulation models are associated with world views, including the process-interaction orientation. Historically, these models have been encoded using high-level programming languages or special purpose (typically vendor-specific) simulation languages. These approaches complicate simulation model reuse and interchange.

The current document-centric World Wide Web is evolving into a Semantic Web that communicates information associated with ontologies. The Web Ontology Language – OWL, is being used to encode an ontology for representing discrete event process-interaction models (DEPIM). The DEPIM ontology is being developed using a documented ontology engineering processes.

The purpose of DEPIM is to provide a vendor-neutral open representation to support model interchange. Model interchange provides an opportunity to improve simulation quality, reduce development costs, and reduce development times.

The DEPIM ontology will contain classes and properties to describe discrete-event simulation models that conform to the process-interaction world view. The ontology will leverage process representation approaches including the one used by OWL-Services (OWL-S).

The use of the DEPIM ontology will be demonstrated by translating models authored by simulation packages into RDF/XML files that conform to the DEPIM ontology. Models described using the ontology will be translated into legacy formats to demonstrate loss-less conversion.

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